REMARKS/ARGUMENTS

Reconsideration of this application is requested. Claims 1-20 are in the case.

Claim Rejections and Amendments

The Examiner objected to claims 2, 9 and 18 on the basis that the first recitation of "eroded image" lacked an antecedent basis. The Examiner suggested that this instance of "eroded image" be amended to "dilated image". In response, claims 2, 9 and 18 have been amended as suggested by the Examiner.

The Examiner rejected claims 1-3 and 5-20 as being anticipated by United States Patent No. 6,728,401 (Hardeberg). The Examiner further rejected claim 4 as being obvious in view of the combined teachings of Hardeberg and U.S. Patent No. 5,748,764 (Benati et al.). These rejections are respectfully traversed. Before addressing the Examiner's rejections in detail, aspects of the present invention and the cited art are summarized below.

Summary of Invention

The present invention involves correcting a red-eye effect in a digital image provided by a cluster of pixels. In a flow chart, Figure 1 lays out different steps that can be followed to achieve this result. As shown in Figure 1, after the digital photograph image is initially provided in step 22, in step 24 this digital image is analyzed to segment small compact red objects within the digital image. This segmentation is performed using at least one tophat operation performed on the image to obtain a tophat image. The tophat operation is conducted to produce a tophat image in which concentrations of red are highlighted. Bright regions in the tophat image will correspond to concentrations of red in the original image. The resulting tophat image is then subjected to an intensity threshold to identify regions of sufficient brightness to become objects of interest. Of these objects, only objects with compactness less than a compactness threshold are retained as objects of interest, such that elongated patches of redness are removed to produce a segmentation mask. In this segmentation mask, segmented objects are represented by white pixels and all of the other pixels are black. Subsequently, features are extracted from the digital image for each object, and the segmented object is then classified based on the abstracted feature set. In particular, each segmented object is classified based on the probability that the object is a red-eye defect.

Hardeberg

Hardeberg begins by computing a color difference mask for indicating the color difference of each pixel relative to a red-eye artifact reference: pixels close to the red-eye artifact reference are lighter, and those that differ significantly are darker. This is shown in Figure 3c. Subsequently, as shown in Figure 3d, a binary segmentation mask is produced in which pixels that exceed the threshold color difference are black (not indicative of red-eye), while those below this threshold are white (indicative of red-eye). Then, as described below, and as shown in Figures 6 and 7, various filtering and adjustment method can be applied to this binary segmentation mask. In particular, Hardeburg describes morphological filtering as follows:

> "In block 630, morphological filtering is done on the mask to eliminate noise components, smooth contours, fuse brakes [sic], and fill gaps." Col 7 Lines 24-26

For the purposes of the argument that follows, it is important to note that this morphological filtering step is conducted on the binary mask after a threshold operation is conducted to generate the binary mask. In other words, in Hardeberg, the threshold operation precedes the morphological filtering step. Further, it is also important to note that the purpose of the morphological filtering step is quite different than that of the tophat operation. That is, the tophat operation aims to highlight concentrations of red in the image. In contrast, the purpose of the morphological filtering step described by

Hardeberg is to "eliminate noise components, smooth contours, fuse brakes [sic] and fill gaps."

Detailed Reply to Claim Rejections

In the Office Action, it appears that the Examiner is taking the position that the morphological smoothing operation described by Hardeberg corresponds to the tophat operation claimed. This position is respectfully traversed. Specifically, the morphological smoothing operation Hardeberg describes is used to smooth a binary segmentation mask previously developed by thresholding a color difference mask. In other words, the morphological smoothing operation is applied after thresholding and segmentation.

Claim 1 of the present application begins as follows:

> "A method of correcting a red-eye effect in a digital image provided by a cluster of pixels, the method comprising:
>
> (a) conducting at least one tophat operation over each pixel in the digital image to provide a tophat image;
>
> (b) conducting an intensity threshold operation on the tophat image to provide a segmentation mask for segmenting objects in the digital image;...."

There are a number of reasons why the morphological filtering operation described by Hardeberg cannot be said to correspond to the tophat operation recited in step a) of claim 1, some of which will be explored below. However, say, for the sake of argument, that the morphological filtering operation described by Hardeberg does correspond to the tophat operation recited in step a) of claim 1. The question then becomes, how can Hardeberg be read so as to provide the limitations of step b) of claim 1?

The Examiner takes the position that Hardeberg discloses conducting an intensity threshold operation on the tophat image to provide a segmentation mask for segmenting objects in a digital image in Figure 5, and from column 6, line 66 to column 7, line 19. These portions of Hardeberg do, indeed, disclose comparing each pixel of a mask to a threshold value to determine if the mask value is greater than the threshold value, and thereby construct a binary mask. However, this threshold step is not conducted on a tophat image, or even on a morphologically smoothed image as per Hardeberg, as Hardeberg clearly describes that morphological filtering is conducted on the binary mask itself. In other words, the morphological filtering that the Examiner takes as corresponding to the tophat operation is actually applied to the binary mask **after** the binary mask has been constructed using the intensity threshold operation. However, in step b) of claim 1 the intensity threshold operation is conducted on the tophat image, obtained by conducting the tophat operation before the intensity threshold operation.

Accordingly, it is respectfully submitted that the various portions of Hardeberg identified by the Examiner as satisfying the limitations of claim 1, do not in fact satisfy the limitations of claim 1, as there is nothing in Hardeberg corresponding to step b) of claim 1 in which an intensity threshold operation is conducted on the tophat image to provide a segmentation mask for segmenting objects in the digital image. Specifically, as described above, the tophat image highlights concentrations of red in the image. The intensity threshold operation is then applied to this tophat image to provide the segmentation mask. The morphological filtering step described by Hardeberg is applied after the binary mask has been constructed, which makes sense given that this morphological filtering step is intended to eliminate noise components etc.

If the Examiner elects to maintain this rejection, then clarification is respectfully requested. Specifically, the Examiner is requested to specifically identify what in

Hardeberg corresponds to the tophat image on which the intensity threshold operation is allegedly conducted. Specifically, if the Examiner takes the morphological filtering operation described by Hardeberg as corresponding to the tophat operation recited in step a) of claim 1, then the Examiner cannot take the tophat image to be the color difference mask, as this color difference mask is not provided by the morphological filtering operation but instead is converted into a binary mask on which the morphological filtering operation is subsequently conducted.

Additional Arguments

A further difference between the present invention as claimed and Hardeberg emerges from consideration of claim 2. Specifically, the Examiner takes the position that Hardeberg discloses conducting greyscale dilations and erosion at column 8, lines 38 to 49 and in Figures 7. In fact, the operations described are morphological filtering operations applied to binary image data and not to greyscale image data at all. The purpose served by these morphological filtering operation disclosed by Hardeberg is to eliminate noise, and smooth and fill gaps in binary images. In contrast, the purpose of the tophat operation of the present invention, as defined in claim 2, is to segment potential red-eyes in a greyscale image by conducting at least one greyscale dilation operation, at least one greyscale erosion operation, and at least one subtraction step.

It is respectfully submitted that remaining method claims 3 to 7 all clear the art cited for the reasons provided above. Specifically, Hardeberg neither teaches nor suggests conducting an intensity threshold operation on a tophat image to provide a segmentation mask for segmenting objects on the digital image.

For analogous reasons it is respectfully submitted that system claims 8 to 16 and computer program product claims 17 to 20, also clear the art cited.

In view of the foregoing, it is respectfully submitted that the claims are allowable over the cited references. Allowance of the application is respectfully requested.

If any questions arise, it is requested that the undersigned be contacted at the number provided below.

Respectfully submitted,

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